Ph. D. Pre-registration Synopsis

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Pre–registration Synopsis
on

Design and Performance Evaluation of Solar Dryer for Agricultural Products

For the Doctoral Degree in Mechanical Engineering

Submitted
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Submitted
to
Research and Recognition Committee

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NANDED – 431606, Maharashtra State, India

2018 – 19

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1. Introduction:

India produced about the 400,000 tone of turmeric, which was about 80% of the world's supply of commercial turmeric. Turmeric are processed and then dried before transport to the other countries. It has the lot of application in the Curries, spices and medical field. Curcumin is the main parameter which defines the quality of the turmeric and it defers around 1.06% to 5.70% in every batch of the turmeric. After harvesting from the land, turmeric requires blanching and in the blanching maximum loss of the Curcumin takes place. (A. Borah, 2015)

Dehydrating the agricultural products is the oldest method for preservation and conservation to reduce bacterial and fungal growth. In the developing country like India agricultural products are generally dehydrated by using the traditional open sun drying method. Open sun drying have the some advantages like not required the special attention, special energy, so simple in operation and this is the cheapest method of the dehydration. (A. K.Bhardwaj, 2019)

Drying continue to be the most widely used method for the preservation of the several agricultural products. In India sun drying is commonly used due to most economical and simple method for the drying. It has many disadvantages like the dried product may be contaminated with insect, dust, excreta of wondering animals. (Pranav Mehta, 2018)

Solar dryers used for the agricultural products are very useful devices. Solar dryer does not consume any kind of fossil fuels. Solar dryers make the process more efficient, quality of the product increases and it also protect the environment. Solar dryers are generally classified into the three forms based on the mode of operation i.e. Direct type, indirect type and mixed mode

type. Direct type solar dryer are directly exposed to the solar irradiation and dry the product. Indirect solar dryer is associated with the separate absorber to absorb the solar irradiation and preheat the air. The heated air passes inside the drying chamber where the product is loaded. This chamber does not have contact with the outside solar irradiation. Mixed mode dryer has a device for preheating the air and also transparent wall of drying chamber. Due to the transparent walls of the chamber maximum radiant energy absorption takes place. Sometimes in the solar dryer large type of solar heater also used for heating in off sunshine hours and it makes mixed mode solar dryer more expensive. (Wei Chen, 2014)

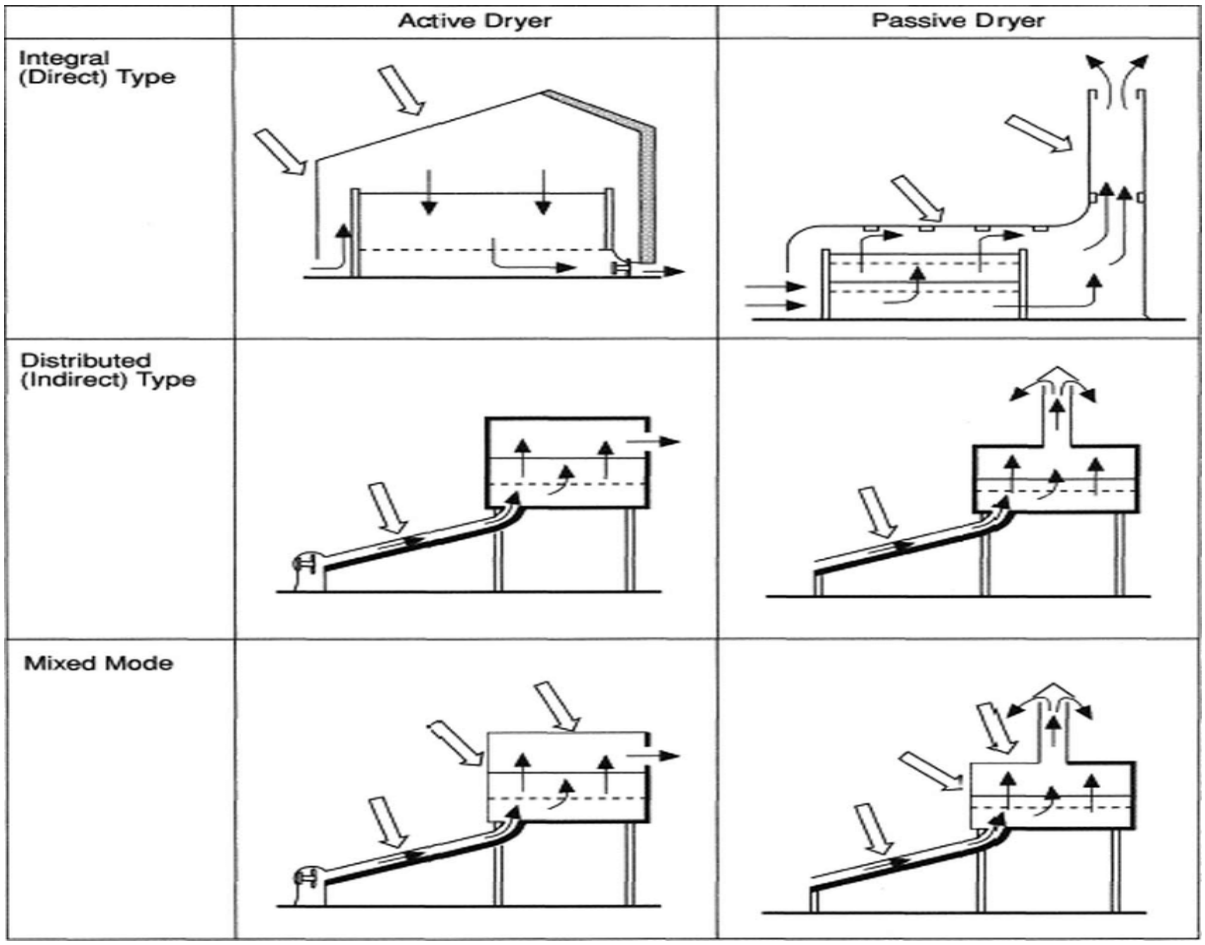

Figure 1: Types of Solar dryer **(Visavale, 2012)**

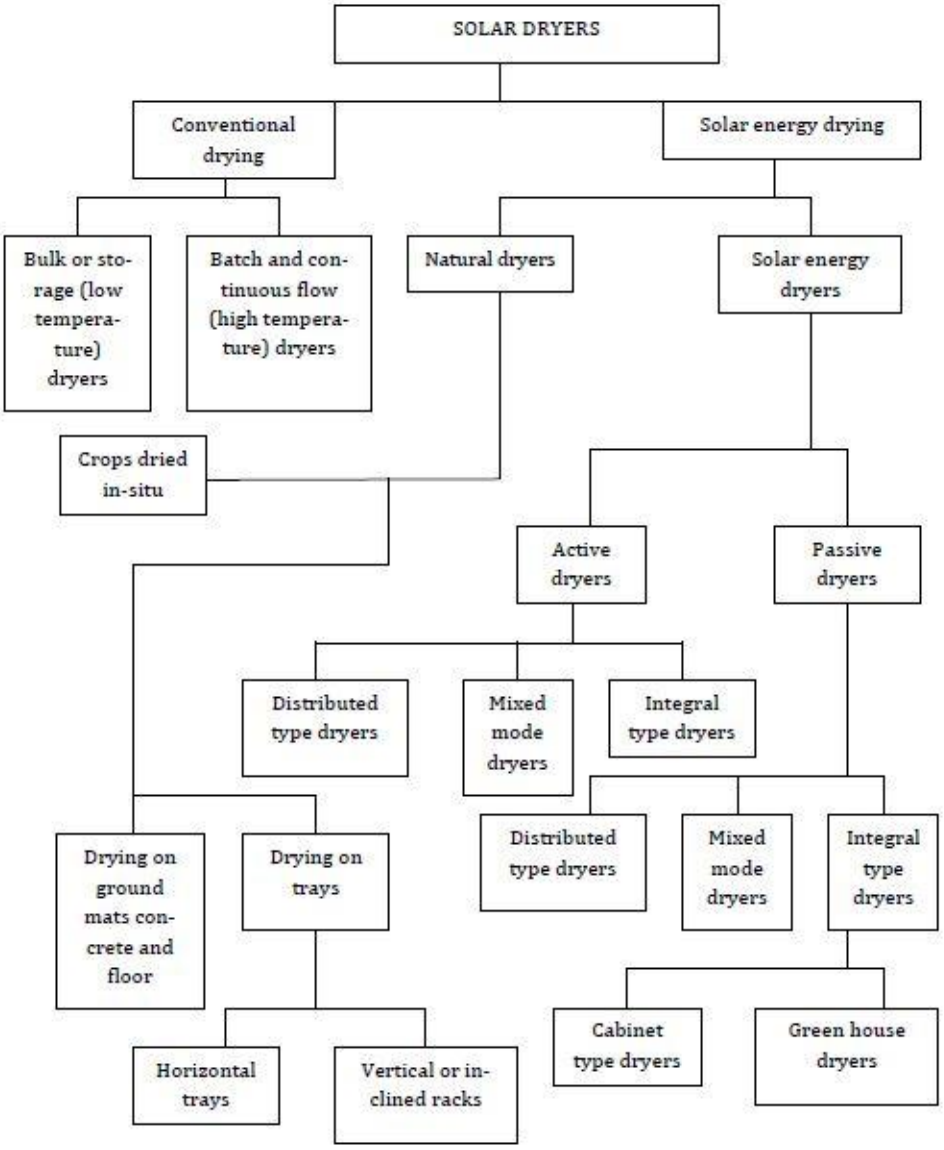

Figure 2: Classification of Solar Dryer (Visavale, 2012)

2. Literature Review:

S. Murali et at. investigated the quality characteristic and drying kinetics of India Mackerel dried under the solar under the solar-electrical hybrid dryer. Temperature, relative humidity and air velocity under the solar-electrical hybrid dryer were maintained 45-55^{0}C, 47-62% and 0.60-0.80m/s respectively. Moisture content reduced to 31.8% (w.b.) under solar-electrical hybrid dryer and 61.5 % (w.b.) in 8hr and 32hr respectively. Author carried out the sensory analysis; sample dried under solar-electrical hybrid dryer recorded highest overall acceptability score. (S. Murali, 2019)

A. K. Karmikeyn et al. reduced to 0.07 from 0.779 (kg of water /kg dry matter) in 12 hr. Inclination of the solar air heater was a key advantage of mixed mode force convective type solar tunnel dryer for effective harnessing of solar radiation. Exergetic efficiency of the dryer was found to be 49.12 % along with energy utilization ratio in the range of 9.95-33.98 %. In the study the eleven mathematical models were applied to understand the behavior of the turmeric. (A.K. Karthikeyan, 2018)

J. John Gunasekar et al. evaluated the solar drying for turmeric. There are biochemical constituents which may vary depending upon the drying method. Due to biochemical constitutes the quality of turmeric may get influenced at various moisture contents. As the moisture content decreases the volatile oil, oleoresin and total protein decreases. Curcumin content was found intensified along with boiling and drying. Curcuma varies non-linearly; it increases as moisture content decreases. Initially it was found 2.89 g per 100 g at 79.04 % (wet bulb) moisture level. It varies from 2.89 g to 4.56 g per 100 g of sample in sun drying and it was found 4.49 g per 100 g of sample in solar dried sample. As per the variation of volatile oil is concerned, it shows a small variation in sun drying and solar drying. Before drying it was found 6.0 ml per 100 g of sample and after drying 5.26 and 5.20 ml per 100 g in sun dried and solar dried samples respectively.

After drying the oleoresin was found 8.98 and 9.22 g per 100 g of sample in sun drying and solar drying. Initially before drying it was 9.86 g per 100 g of sample. It decreases non-linearly. Boiled turmeric initial had a 1.25 g per 100 g of sample but it also decreases linearly 1.14 g per 100 g and 1.78 g per 100 g of sample in solar dried and sun dried. It contain more protein than sun dried hence biologically and theoretically better product when it dry in solar dryer. (J. John Gunasekar, 2006)

A. Boran et al. designed solar turmeric dryer in a solar conduction dryer. Temperature inside the dryer was around 39-510C. Ambient temperature was measured in the range of 25-280C. For solid and sliced turmeric experiments carried out and it was found that the final moisture content was 6.36 % (wet basis) and 5.50 % (wet basis) for solid and sliced turmeric from 78.65 % (wet basis) within 12 hr. For solid average effective moisture diffusivity found 1.456 *10-10 m2s-1 and for sliced turmeric 1.852 *10-10 m2s-1. Rate of drying for sliced turmeric was much faster than the whole turmeric. In open sun drying process of same sliced turmeric requires 25.5 hr and it was affected by the white patches of fungal growth. No fungal growth is found in the solar collective dryer. In this research Lewis, Page, Modified Page and Henderson and Pabis were tried, out of these Pages model was found as best fitted for simulation. (A. Borah, 2015)

D. V. N. Lakshmi et al. checked the performance of mixed mode type forced convective dryer for sliced turmeric integrated with the thermal storage by using paraffin wax. Sliced turmeric were dried in open sun and mixed mode forced solar dryer from moisture level 73.4 % to 8.5 % (wet basis) in 18.5 hr, sliced sample took 46.5 hr in open sun drying. Two term model took 46.5hr in open sun drying. Solar dryer efficiency was found 12 % along with solar air heater efficiency 25.6 %. Paraffin wax in liquid state is used as the solar storage. 60 % of time

was saved by the mixed mode solar dryer. The total flavonoids for mix-mode type solar dryer found 7.59 mg quercetin per g of sample as it was found 10.99 and 7.09 fresh and solar dried respectively. From study it was found that mix-mode solar dyer has a high medical agriculture value. (D.V.N. Lakshmi, 2018)

3. Research Methodology:

The proposed work will be carried out by design, experimental investigation and analysis of solar dryer working on the Compound Parabolic Concentrator and Schefller.

3.1 Problem Statement:

After reading the literature review there are so many solar dryers are designed for the different product. Very few solar dryer is designed for turmeric drying purpose. The turmeric is having more amount of the moisture that is challenging for the researcher.

3.2 Methodology:

Following methodology will carry out throughout the Ph.D. work.

- ➢ Phase 1: Design of the solar dryer.
- ➢ Phase 2: Performance of the solar dryer is evaluated.
- ➢ Phase 3: Different temperature is finding out inside the solar dryer.
- ➢ Phase 4: Performance of solar dryer is evaluated working on Scheffler.
- ➢ Phase 5: Performance of solar dryer is evaluated working on Compound parabolic concentrator.
- ➢ Phase 6: Comparative study is carrying out.

4. Objective:

1. To design and fabricate solar dryer, suitable for agricultural products.
2. To analyze the performance of the solar dryer coupled with Scheffler.
3. To analyze the performance of the solar dryer coupled with Compound Parabolic Concentrator.
4. To compare the performance of solar dryer of two systems i.e. Scheffler and Compound Parabolic Concentrator.
5. To conduct suitable experiments for desired outcome.

5. Expected Outcomes:

This study consist an experimental analysis of the solar dryer. The proposed work will be an attempt to find out the new solution of the turmeric drying. This work will propose the new solution to the farmer which would be less time consuming.

With the proposed work planned to be undertaken, the following outcomes are expected to be achieved.

1. Reduced drying time.
2. Improvement in quality of turmeric (Curcumin %).
3. Cost effective and affordable solar dryer for farmer.
4. Patent on the solar dryer.

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